CPA/ERAC ROTARY KILN INCINERATION STUDY

A Study of Rotary Kiln Incineration
of Oily Sand Wastes

EC-90368 October 1986

Prepared for
The Canadian Petroleum Association
Environmental Research Advisory Council

Prepared by
Hardy BBT Limited
4810 - 93 Street
Edmonton, Alberta

CANADIAN PETROLEUM ASSOCIATION

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ABSTRACT

Hardy BBT Limited was asked to perform a source emission survey and study of the disposal of oily wastes using rotary kiln incineration, by Mr. Mark Philpott, Chevron Canada Resources Limited.

The study was commissioned by the ERAC group of the Canadian Petroleum Association.

In cooperation with Esso Resources Canada Limited a test burn of oily sand waste using Esso's rotary kiln incinerator and wastes generated from their Cold Lake Facility was investigated by Hardy BBT Limited on October 31, 1986.

The primary objective was to evaluate the performance and environmental acceptability of rotary kiln incineration as a disposal method for oily wastes.

During the emission survey representative samples of the oily wastes from Esso's ecology pits were incinerated and the emissions of particulates, sulphur oxides, oxides of nitrogen, hydrogen chloride and chlorine determined.

Samples of the oily waste, residual ash and particulate emissions were collected and analyzed for characterization.

Rotary kiln incineration of oily waste from the heavy oil industry shows promise. The combustion process works well, is controllable, and the residual ash generated has potential for appropriate landfill disposal. The incinerator does however require modification in design so that air contaminant emission standards are complied with.

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3	Collected Particulate Emission Analysis
4	Incinerator Residual Ash Analysis
5	EPA Ash Leachate Analysis and Alberta Hazardous Chemicals Act Comparison

1.0 STUDY OVERVIEW

1.1 Objectives

This report has been prepared for the Canadian Petroleum Association and Environmental Research Advisory Council to assess the disposal of oily wastes using rotary kiln incineration. In cooperation with Esso Resources Canada Limited a test burn of oily waste using Esso's rotary kin incinerator and wastes generated from their Cold Lake Facility was investigated by Hardy BBT Limited on October 31, 1986. The specific objectives of the report are:

- To determine the source emissions resulting from the oily waste incineration process for comparison with Alberta Environment's Guidelines for Design and Operation of Incinerators in Alberta.

- To provide chemical analysis of:
  - composite waste
  - collected particulate emissions
  - composite incinerator ash
  - ash leachate

- To evaluate the environmental acceptability of rotary kiln incineration as a disposal method for oily wastes based on the investigation.

These objectives require that the air emissions generated during incineration are acceptable and meet provincial guidelines (regulations) and that the residual material (ash) generated after incineration can be disposed of routinely in an appropriate landfill site.

To achieve these objectives:

- o emission surveys were performed for particulates, sulphur dioxide, oxides of nitrogen, hydrogen chloride, chlorine, and hydrocarbons for Alberta Environment compliance.
- o carbon dioxide, oxygen, carbon monoxide, nitrogen and moisture were monitored in the exhaust gases and velocity and temperature profiles generated.
- o oily wastes were characterised prior to incineration.
- o collected particulates and residual ash samples were analyzed for elemental composition.
- o an EPA leachate toxicity test was performed to determine the acceptability of the material for landfill disposal.

2.0 REPORT SUMMARY

2.1 Rotary Kiln Incinerator Survey

The rotary kiln incinerator survey was performed on a modified Aqua Guard Sales Inc. Rotary Kiln Incinerator, Rotrin Mark 1. (General description and operation brochure is included in Appendix C.) Aqua Guard Sales Inc. personnel operated the incinerator and Lisa Holzman of Esso Resources Canada Ltd. was the on-site coordinator.

Oily wastes generated from Esso's Cold Lake Heavy Oil Facility were used as the incinerator feed material for assessment of the incineration process. Samples of the ecology pit wastes were taken prior to the survey for characterization and results of the analysis are presented in Table 1.

Sand material was combined (1:4) with oily wastes from the ecology pits to give a final oil content in the feed material of approximately 9.5 percent based on random sampling.

Oily waste sands were mixed and loaded using a Bobcat loader onto a conveyor which fed the incinerator hopper. Wastes were then fed into the kiln via a screw feed. Incinerator feed during the survey was continuous and the charge rate was estimated at 1.1 cubic meters per hour (1.93 tonnes per hour) using hopper volume capacities and screw feed rotation.

The following survey operational data for the incinerator was supplied by Aqua Guard Sales Inc.

Kiln Angle	1.5 degree slope from burner to kiln exit
Kiln Rotation	2 rpm
Average Fuel Consumption (propane)	164 litres/hour
Kiln Inlet Temperature	approximately 750^{o}C
Kiln Outlet Temperature	approximately 1100^{o}C

The incinerator was fired prior to the air contaminant emission survey to achieve optimum operating conditions. After an initial start-up period the combustion process was fueled in part by the oily waste feed, and combustion temperatures were controlled by the propane burner operation. The combustion process controlled well throughout the survey period, with the exception of one occasion when excessive build up of combustibles in the kiln caused temporary delays.

Three emission tests according to Alberta Environment's requirements for particulate, sulphur dioxide, oxides of nitrogen, hydrogen chloride and chlorine were then conducted over a 6 hour burn period. Average emission rates and concentrations are summarized in Table 2.

Analysis of the combined collected particulate emissions are detailed in Table 3. The detailed source emission report is enclosed in Appendix B.

Waste residual ash was removed from the exit of the kiln combustion chamber and composite samples representative of the individual emission test periods were collected for analysis and EPA leachate testing. Residual ash and leachate analysis are provided in the respective tables 4 and 5.

Sampling and analysis methodology references are given in Appendix A.

Photographs of the incinerator operation during the survey complete the appendices.

2.2 Results

Air contaminant emissions and analytical results are presented in the following tables.

Table 1	Esso Cold Lake Ecology Pit Oily Waste Analysis
Table 2	Source Emission Survey Results and Alberta Environment's Guidelines for Design and Operation of Refuse Incinerators in Alberta Comparison
Table 3	Collected Particulate Emission Analysis
Table 4	Incinerator Residual Ash Analysis
Table 5	EPA Ash Leachate Analysis and Alberta Hazardous Chemicals Act Comparison

TABLE 1

Esso Cold Lake Ecology Pit Oily Waste Analysis

Analysis Parameter	Composite Sample #1	Composite Sample #2
Oil (%)	28.9	28.7
Solids (%)	54.4	53.3
Water (%)	16.7	18.0
Ash (%))	43.4	40.5
Carbon (%)	33.0	34.5
Hydrogen (%)	5.8	5.9
Nitrogen (%)	0.5	0.4
Sulphur (%)	1.7	1.6
Oxygen (%)	13.9	14.7
Chlorine (%)	0.2	0.2
Calorific Value (Cal/g)	3650	3705
Arsenic (Ug/g)	< 0.40	< 0.40
Boron (Ug/g)	7.6	6.0
Cadmium (Ug/g)	41.1	42.4
Chromium (Ug/g)	38.3	38.3
Copper (Ug/g)	112	139
Lead (Ug/g)	224	168
Manganese (Ug/g)	144	131
Mercury (Ug/g)	1.05	1.05
Molybdenum (Ug/g)	152	194
Nickel (Ug/g)	317	242
Phosphorus (Ug/g)	1.1	0.4
Selenium (Ug/g)	5.9	5.9
Silver (Ug/g)	29.2	29.2
Tin (Ug/g)	0.65	< 0.40
Vanadium (Ug/g)	74.2	83.2
Zinc (Ug/g)	33.4	108
Aluminum (%)	1.63	1.91
Barium (%)	0.08	0.07
Calcium (%)	2.38	2.62
Iron (%)	0.49	0.65
Magnesium (%)	0.05	0.05
Potassium (%)	1.22	1.23
Silicon (%)	32.3	26.2
Sodium (%)	1.22	1.26

TABLE 2

Source Emission Survey Results and
Alberta Environment's Guidelines for
Design and Operation of
Refuse Incinerators in Alberta Comparison

	Survey Emissions (Average)	Alberta Environment Guidelines
Particulate (kg/1000 kg flue gas)	19.1	0.2
Hydrogen Chloride (ppmv @ 50% EA)	141.0	100
Sulphur Dioxide (ppmv @ 50% EA)	962	250
Oxides of Nitrogen (ppmv)	14.7	N.G.L.*

* N.G.L. - No Given Limit

TABLE 3

Collected Particulate Emission Analysis

Analysis Parameter	Particulate Composite Sample
Silver (ug/g)	168
Arsenic (ug/g)	4.40
Boron (ug/g)	6.98
Cadmium (ug/g)	55.9
Chromium (ug/g)	< 16.0
Copper (ug/g)	160
Mercury (ug/g)	0.33
Manganese (ug/g)	154
Molybdenum (ug/g)	66.3
Nickel (ug/g)	184
Phosphorus (ug/g)	615
Lead (ug/g)	154
Selenium (ug/g)	< 5
Tin (ug/g)	25.0
Vanadium (ug/g)	110
Zinc (ug/g)	148
Aluminum (%)	1.51
Barium (%)	0.18
Calcium (%)	2.33
Iron (%)	0.96
Potassium (%)	1.49
Magnesium (%)	0.04
Sodium (%)	1.24
Silicon (%)	37.89

TABLE 4

Incinerator Residual Ash Analysis

Analysis Parameter	Ash Samples Test #1	Test #2	Test #3
Silver (ug/g)	559	179	169
Arsenic (ug/g)	0.36	0.34	0.38
Boron (ug/g)	22.5	18.2	14.0
Cadmium (ug/g)	72.0	59.5	42.3
Chromium (ug/g)	67.8	35.1	<16.0
Copper (ug/g)	165	299	121
Mercury (ug/g)	0.154	0.574	0.272
Manganese (ug/g)	169	109	72.4
Molybdenum (ug/g)	84.5	83.7	89.2
Nickel (ug/g)	628	196	233
Phosphorus (ug/g)	0.24	0.18	0.15
Lead (ug/g)	264	218	103
Selenium (ug/g)	< 5	< 5	< 5
Tin (ug/g)	119	123	1.77
Vanadium (ug/g)	108	75.8	88.0
Zinc (ug/g)	170	132	116
Aluminum (%)	3.61	1.32	1.44
Barium (%)	0.23	0.15	0.19
Calcium (%)	1.79	2.00	1.49
Iron (%)	0.94	0.61	0.51
Potassium (%)	1.49	1.54	1.53
Magnesium (%)	0.14	0.08	0.07
Sodium (%)	1.18	1.45	1.17
Silicon (%)	35.6	36.0	37.4
Loss on Ignition (950^{o}C) (%)	2.27	2.70	1.36
Putrescible Content (C_{sod}) (%)	0.79	0.18	0.52

TABLE 5

EPA Ash Leachate Analysis and
Alberta Hazardous Chemicals Act Comparison

Analysis Parameter	Ash Samples Test #1	Test #2	Test #3	Hazardous Chemicals Act*
Silver (mg/L)	< 0.07	< 0.07	< 0.07	5
Aluminum (mg/L)	3.90	0.60	1.20	-
Arsenic (mg/L)	< 0.001	0.062	0.016	5
Boron (mg/L)	0.78	0.86	0.47	-
Barium (mg/L)	0.67	0.33	< 0.33	100
Calcium (mg/L)	242	148	150	-
Cadmium (mg/L)	< 0.03	< 0.03	< 0.03	1
Chromium (mg/L)	< 0.04	< 0.04	< 0.04	5
Copper (mg/L)	0.18	0.14	0.14	15
Iron (mg/L)	5.77	0.53	1.29	-
Mercury (mg/L)	0.0001	< 0.0001	0.0003	0.2
Potassium (mg/L)	4.14	3.00	2.56	-
Magnesium (mg/L)	68.9	45.0	43.0	-
Manganese (mg/L)	1.35	0.58	0.42	-
Molybdenum (mg/L)	< 0.14	< 0.14	< 0.14	350
Sodium (mg/L)	266	94.9	67.8	-
Nickel (mg/L)	0.21	0.11	0.16	20
Phosphorus (mg/L)	0.03	0.02	0.02	-
Lead (mg/L)	0.38	0.38	0.31	5
Selenium (mg/L)	< 0.25	< 0.25	< 0.25	1
Silicon (mg/L)	28.8	12.9	18.2	-
Tin (mg/L)	< 0.30	< 0.30	< 0.30	1
Vanadium (mg/L)	< 0.30	< 0.30	< 0.30	24
Zinc (mg/L)	0.20	0.13	0.15	20

* Persistent and Bioaccumulative Substances and Their Concentrations Responsible for Classifying a Waste as Being Hazardous

2.3 Incinerator Air Contaminant Emissions

The rotary kiln incineration system for the incineration of oily wastes, does not comply with Alberta Environment's incinerator emission guidelines for air contaminant emissions based on the October 1986 survey. Installation of appropriate pollution control devices and modifications to the design and operations of the incinerator would be required to meet the specific requirements of these guidelines.

A comparison of the surveyed air contaminant emissions and Alberta Environment's incinerator emission guidelines are presented in the Results Table 2. Detailed source emission survey results are attached in Appendix B Source Emission Survey Report.

In general the inorganic ash and gaseous emissions produced during incineration of the oily wastes are attributable to the waste oil feed composition and are independent of the incinerator design or operation.

The amount of fugitive and mechanically entrained particulate emissions are functions of the mechanical and chemical processes taking place in the rotary kiln stage. Other factors affecting solid contaminant discharge include the ratios of combustion air distribution, supplementary draft and temperature criteria, and after burner stage velocity and proportion factors.

Some of the factors required to minimize the air contaminant emissions are direct functions of the desired hourly combustion rates.

Air pollution control equipment requirements would have to be based upon considerations such as required capacity, process conditions, maintenance, capital investment and operating expenses.

2.4 Ash Disposal Requirements

2.4.1 EPA Leachate Testing

The acceptability of hazardous waste for land disposal in the United States is largely based on the results obtained from running the U.S. Environmental Protection Agency Extraction Procedure Test (Appendix D).

Incinerator ash samples collected during the individual source emission survey tests were subjected to EPA Method 1310 leachate analysis to examine specific metals which may have leached. The extraction procedure is designed to simulate the leaching a waste will undergo if disposed of in an improperly designed sanitary landfill. The analysis results are detailed in Table 2.

The EPA leachate toxicity test on the residual ash samples show that the leachants contain low concentrations of hazardous metal ions. It should be noted that the EPA leachate test is a severe test designed to predict the potential for harmful leaching of heavy metals. It cannot predict the rate of leaching with time.

Based on the EPA regulatory definition, the residual ash does not exhibit the characteristic of EP metal toxicity and has potential for disposal in appropriate landfills.

2.4.2 Land Fill Disposal

With respect to the location of an appropriate landfill site to receive the incinerated ash, attention should be paid to the environmental suitability of the site. A major consideration in selecting and designing the site is the hydrology of the area. Leachate is not produced until a major portion of the land becomes saturated by water entering from outside sources. Precipitation, surface runoff characteristics, and the location and movement of groundwater with relation to the ash waste are the major factors that should be considered.

Surface water that infiltrates the landfill can increase the rate of ash leaching and eventually cause leachate to leave the ash waste and create potential water pollution problems.

Because the conditions affecting groundwater occurence are complex, it is essential that the landfill site investigation include an evaluation of the groundwater location and the aquifer's flow rate and direction be determined.

A study of the soils and geologic conditions of a landfill site should identify the limitations that soils and geologic conditions impose on safe, efficient design and operation. The study should identify and describe the soils present, their variation, distribution and permeability.

Ideally a landfill site should be specifically designated for disposal of the incinerator ash, because of concerns over the non-compatibility of different wastes which may effect possible leachate potential and toxicity.

Alternative disposal methods could include solidification using a cement based process or recycling of the waste sand fractions for oily waste recovery and incineration.

Solidification of wastes using a cement base process is a relatively new treatment which consists of mixing waste with cement and possibly other additives. Through cementation of the mixture heavy metals in the waste are converted to insoluble hydroxides and silicates in the alkaline environment of the cement paste and are trapped within the pores of the cement paste matrix. Testing of the solidified product may identify potential usage as a construction material.

2.5 Conclusions and Recommendations

The incineration of oily waste using a rotary kiln incinerator shows promise. The combustion process works well for the destruction of the oily waste, and is controllable and the residual ash generated has potential for disposal in appropriate landfills.

The stack emission generated during the combustion process are high and particulates, sulphur dioxide and hydrogen chloride emissions exceed the requirements of Alberta Environment. It is thought that relevant procedure modifications and additional pollution control devices would be necessary to bring the emissions of all parameters into compliance. Fugitive emissions from the rotary kiln seals and the ash discharge are also excessive and require modification. The high quality of the residual ash and it's potential acceptability for landfill disposal suggest that these modifications to the incinerator merit investigation.

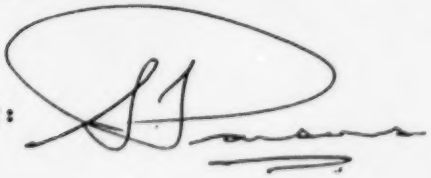
Initially, optimization of the incinerator was to be preformed prior to emission testing. This would have entailed one or two days of trial runs prior to the survey. This was not done due to scheduling difficulties and although the incinerator functioned quite well during the survey, some benefits could have been achieved from pre-test runs.

Recommendations:

- o Identify whether or not the incineration process will supply the capacity requirements necessary based on predicted oily waste volumes.
- o Assess modifications required to control fugitive emission sources and residual ash handling systems.
- o Evaluate a water scrubber system for stack exhaust gas clean-up.
- o Assess on-site areas for locating an ash landfill site with appropriate environmental monitoring controls.
- o Assess the use of the residual ash in recycle processes which would constitute disposal
  - in asphalt manufacture
  - as a fill material
  - in road bed construction
  - in concrete
  - in oily waste recovery

Respectfully Submitted

HARDY BBT LIMITED

Per: 

Shannon P. Parsons
Manager
Chemistry Division

APPENDIX A

STUDY METHODOLOGY

APPENDIX A

STUDY METHODOLOGY

Test Methods

Sampling and analytical procedures are outlined below. All procedures used are standard methods and were discussed with Alberta Environment and CPA personnel prior to the survey.

Source Emission Survey

The sampling and analysis methods followed Alberta Environment's standards. The following referenced procedures are provided:

Particulate (SSC-1/76 Method 4)
Sulphur Dioxide (SSC-1/76 Method 5)
Oxides of Nitrogen (SSC-1/76 Method 6)
Hydrogen Chloride and Chlorine (AECV85-M1 Method No. 42525)

Hydrocarbon emissions were collected in tedlar gas sampling bags and subsequently analyzed by gas chromatography for C_1 to C_7 hydrocarbons. One sample per test, three per survey were collected and analyzed by appropriate standard comparison.

Stack gas composition was monitored on-site using a Nova Model 370 flue gas analyzer for oxygen, carbon dioxide, and carbon monoxide. This method allows continuous monitoring of excess combustion air. The unit was calibrated on-site with appropriate calibration standards, and cross-checked against the fyrite gas analyzers.

Composite Oily Waste Analysis

Calorific values were generated using a bomb calorimeter, oil, sand and water analyses were obtained using a modified Dean & Stark technique. Carbon, hydrogen, nitrogen, sulphur, oxygen and chlorine analyses were determined using an organic elemental analyzer where the sample was burned and the carbon dioxide, water, etc. analyzed.

The oily waste was analyzed using a fusion, acid digestion sample preparation followed by atomic absorption analyses.

The following elements were analyzed in all samples indicated:

Silver	Aluminum
Arsenic	Boron
Barium	Calcium
Cadmium	Chromium
Copper	Iron
Mercury	Potassium
Magnesium	Manganese
Molybdenum	Sodium
Nickel	Phosphorus
Lead	Selenium
Silicon	Tin
Vanadium	Zinc

Ash Analysis

Ash analysis was performed to CSA Z103 specification looking for combustible and putrescible carbon contents. Ash composition was determined using a fusion, acid digestion step and atomic absorption determination of the elements listed above.

Collected Particulate Analysis

Samples were treated as for the ash analyses, however, the three particulate catches (one survey data) were combined and analyzed since the sample size was small.

Leachate Analysis of Ash

The ash or residue from the burn was subjected to the EPA leachate toxicity test (Method 1370). The sample of residue was extracted over a 24 hour period using pH 5.0 water. The material was filtered and the filtrate analyzed for the list of elements as given above.

APPENDIX B

SOURCE EMISSION SURVEY REPORT

WASTE OIL INCINERATION STUDY
SOURCE EMISSION SURVEY
ROTARY KILN INCINERATOR
ESSO RESOURCES CANADA LTD.
COLD LAKE, ALBERTA

EC-90368 OCTOBER 1986

PREPARED FOR

THE CANADIAN PETROLEUM ASSOCIATION

PREPARED BY

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WRITTEN BY: S. PARSONS

1.0 SUMMARY

Hardy BBT Limited conducted a source emission survey study at Esso Resources Canada Ltd., Cold Lake, Alberta on October 31, 1986. During the October 31 survey the Mark 1 Rotary Kiln Incinerator stack gas effluent was sampled.

This study was undertaken to determine particulate, hydrogen chloride, chlorine, sulphur dioxide, hydrocarbon and oxides of nitrogen emission rates and concentrations during the incineration of oily wastes produced at Esso's Cold Lake Operations.

Particulate mass emission rates ranged from 148 to 162 kilograms per hour, with a corresponding concentration range of 18.7 to 19.5 kilograms per thousand kilograms flue gas. These results were based on the total particulate catch.

Hydrogen chloride mass emission rate ranged from 0.7 to 1.2 kilograms per hour, with a concentration range of 107.8 to 175.4 parts per million by volume (dry) at 50 percent excess air.

Chlorine concentrations were less than 1.0 parts per million by volume (wet).

Sulphur dioxide mass emission rates ranged from 12.6 to 17.0 kilograms per hour, with a corresponding concentration range of 903 to 1055 parts per million by volume (dry) at 50 percent excess air.

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Oxides of nitrogen (expressed as NO_2 equivalent) mass emission rates ranged from 0.12 to 0.27 kilograms per hour with a corresponding concentration range of 8.7 to 20.9 parts per million by volume (wet).

Hydrocarbon C_1 to C_{6+} concentrations were less than 5.0 parts per million by volume (dry).

2.0 DISCUSSION

No problems were encountered during survey sampling or analysis and the results are believed to be representative of exhaust stack conditions at the time of testing.

The incineration feed rate was approximately 1.1 cubic meters per hour (1.93 tonnes per hour) of oily waste and sand mixture which contained approximately 9.5 percent oil by weight.

Feed material density based on a loose unit weight, averaged 1750 kilograms per cubic meter.

3.0 TEST METHODS

The source sampling equipment incorporated in this survey were High Volume Stack Samplers manufactured by Napp Inc. and Accurex Inc. The sampling probe was specifically designed using quartz liner - nozzles. Impinger boxes were also redesigned for six glass impingers; two in a water bath and four in an ice bath as required in Method 42525. These systems and pollutant collection and analysis methods comply with the Alberta Environment Source Sampling Code (Publication SSC-1/76) for testing of particulate, sulphur dioxide, and oxides of nitrogen emissions, and Alberta Environment Methods Manual for testing of chlorine and hydrochloric acid gas (Method 42525). Hydrocarbon C_1 to C_{6+} samples were collected in Tedlar gas sampling bags and analyzed by a Varian Model 3700 gas chromatograph with flame ionization detection.

The most recent calibrations of the equipment used in this survey, were carried out in January and September, 1986.

Particulate, hydrogen chloride and chlorine sampling was incorporated in the same sampling train and were sampled simultaneously. Oxides of nitrogen, sulphur dioxide and hydrocarbon tests were performed in conjunction with these tests over the same time period.

4.0 RESULTS

From the emission survey data, the pollutant emissions were calculated and the results are summarized in the attached tables.

Table 1 Particulate Emission Rates and Concentrations
Table 2 Hydrogen Chloride and Chlorine Emission Rates and Concentrations
Table 3 Sulphur Dioxide Emission Rates and Concentrations
Table 4 Oxides of Nitrogen Emission Rates and Concentrations
Table 5 Hydrocarbon Emission Rates and Concentrations
Table 6 Calculated Excess Air Percentages for each Test

Respectfully submitted

HARDY BBT LIMITED

Per:

Shannon P. Parsons
Manager
Chemistry Division

SPP/jds/6,6/88

TABLE 1

PARTICULATE EMISSION RATES AND CONCENTRATIONS

OCTOBER 31, 1986 SURVEY

Test #	Time	Concentration kg/1000 kg flue gas	Mass Emission kg/hour	Mean Isokinetic Variation (Percent)
1	1340-1448	19.5	161.6	93.6
2	1600-1705	18.7	147.7	94.4
3	1730-1835	19.0	149.8	95.1
	Average	19.1	153.0	94.4

Note: Particulate emissions are based on total particulate catch

TABLE 2

HYDROGEN CHLORIDE AND CHLORINE
EMISSION RATES AND CONCENTRATIONS

OCTOBER 31, 1986 SURVEY

Hydrogen Chloride

Test #	Time	Concentration ppmv (wet)	Concentration ppmv (dry) @ 50% EA	Mass Emission kg/hour
1	1340-1448	110.3	139.8	1.1
2	1600-1705	125.1	175.4	1.2
3	1730-1835	74.3	107.8	0.7
	Average	103.2	141.0	1.0

Chlorine

Test #	Time	Concentration ppmv (wet)	Mass Emission kg/hour
1	1340-1448	< 1.0	< 0.1
2	1600-1705	< 1.0	< 0.1
3	1730-1835	< 1.0	< 0.1
	Average	< 1.0	< 0.1

TABLE 3

SULPHUR DIOXIDE

EMISSION RATES AND CONCENTRATIONS

OCTOBER 31, 1986 SURVEY

Test #	Time	Concentration ppmv (wet)	Concentration ppmv (dry) @ 50% EA	Mass Emission kg/hour
1	1340-1448	833	1055	17.0
2	1600-1705	644	903	12.7
3	1730-1835	640	929	12.6
	Average	706	962	14.1

TABLE 4

OXIDES OF NITROGEN
EMISSION RATES AND CONCENTRATIONS

OCTOBER 31, 1986 SURVEY

Test #	Time	Concentration Average as NO_2 Equivalent ppmv (wet)	Mass Emission kg/hour
1	1340 - 1448	8.7	0.12
2	1600 - 1705	14.6	0.19
3	1730 - 1835	20.9	0.27
	Average	14.7	0.19

TABLE 5

HYDROCARBON EMISSIONS (C_1 TO C_7)

OCTOBER 31, 1986

Analysis C_1 to C_7	Test #1 1340 - 1448	Test #2 1600 - 1705	Test #3 1730 - 1835
C1 Methane	< 5 trace	6	< 5 trace
C2 Ethane	N.D.	N.D.	N.D.
C3 Propane	N.D.	N.D.	N.D.
C4 Butanes	N.D.	N.D.	N.D.
C5 Pentanes	N.D.	N.D.	N.D.
C6 Hexanes	N.D.	N.D.	N.D.
C7 Heptanes	N.D.	N.D.	N.D.

Detection Limit - N.D. < 5 ppm

TABLE 6

CALCULATED PERCENT EXCESS AIR

OCTOBER 31, 1986 SURVEY

Test #	Percent Excess Air
1	71.9
2	88.5
3	94.4

Calculated excess air is based on the following expression.

$$\% \text{ Excess Air} = \frac{O_2 \text{ mole percent}}{0.266\ (N_2 \text{ mole percent}) - O_2 \text{ mole percent}} \times 100$$

Note: CO concentration were confirmed to be less than 10 ppm for all survey tests.

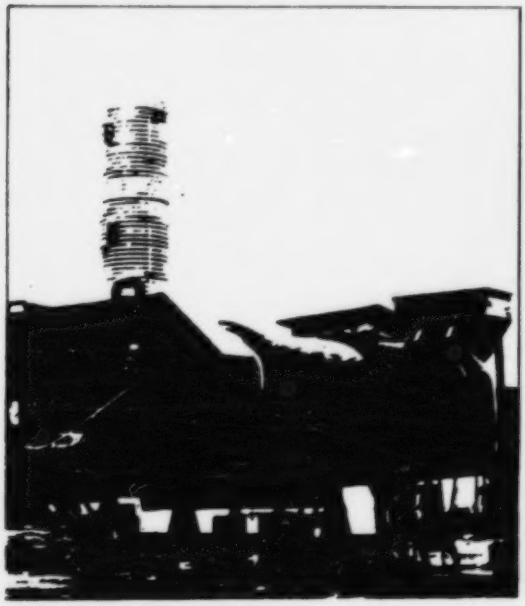
Gas composition values as reported in Appendix A computer output, are the average values of not less than four determinations per test.

APPENDIX C

ROTARY KILN INCINERATOR INFORMATION

ROTARY KILN INCINERATORS.

The problem of disposal of recovered oil and oily debris resulting from oil spills can frequently best be handled by incineration. We have developed two models of Road Transportable Rotary Incinerators (ROTRINS) which are suitable for this purpose. The two models are generally similar except that the larger "MK I" design incorporates an afterburner which extends the dwell time for smoke and gases, resulting in higher temperatures and cleaner emissions. The MK I ROTRIN requires two road trailers for transportation. The "MK II" ROTRIN can be moved on one trailer and is suitable for use in areas where air quality standards are less severe.
All the photographs in this brochure are of the MK I model.

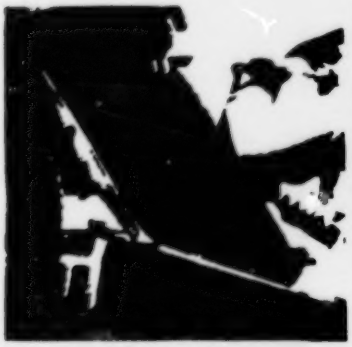


ROTRIN set up on working stands

Detail of afterburner

ROTRIN incinerators are lined throughout with firebrick for increased resistance to high temperatures. Further information is supplied overleaf.

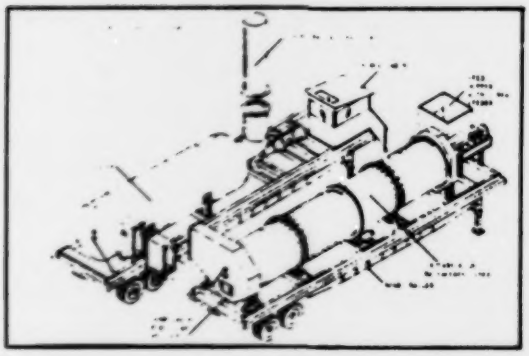
In operation, oily sand or oily debris is loaded into a hopper which is fixed to one end of a rotating kiln. A conveyor may be required to facilitate loading the hopper. A screw conveyor in the bottom of the hopper feeds the oily material into the rotating kiln at a controlled rate. The rotating drum of the kiln is powered by hydraulics and this speed is also controllable. A propane burner is fitted to supply initial heat and make-up heat where required. Most oil sand mixtures require very little extra heat for complete burning. The oily material is tumbled in the rotating kiln and is then discharged through a valve at the far end of the kiln. In the MK I model, gases are further burned in the after burner before exiting to the atmosphere by travelling up an exhaust stack.



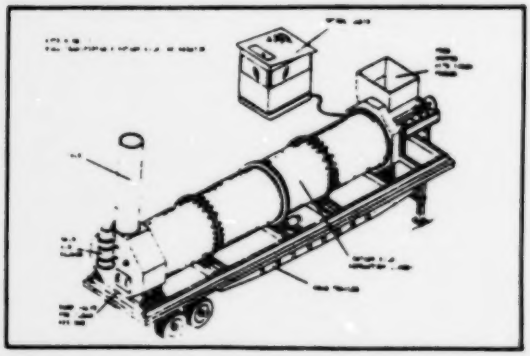
Oily sand is loaded into the ROTRIN

Clean sand is discharged from ROTRIN

Typical emissions from MK I ROTRIN



MK I ROTRIN



MK II ROTRIN

Both machines rotate at a speed of 1 RPM and operate at temperatures of about 1100°C. Combustion is self sustaining with a feed material having an oil concentration in excess of 5 percent with a water content below 15 percent. Under these conditions a ROTRIN can process up to 10 tons of oily waste per hour without excessive smoke.

R.O.T.R.I.N. Mk.I KILN OPERATING CHARACTERISTICS

SPECIFICATIONS.

1. KILN SECTION.

A.	Frame - length	40'
	- width	8'
B.	Hopper Capacity	3 tons
C.	Drum - length	30'
	- internal diameter	5.5'
D.	Lining	4" firebrick and castable refractory
E.	Weight	18 tons

2. AFTER-BURNER SECTION.

A.	Frame - length	40'
	- width	8'
B.	Drum - internal dia.	5.5'
	- lining	4.5" firebrick and castable refractory
	- length	20'
C.	Stack - height	15'
	- internal dia.	3'
	- lining	4" castable refractory
D.	Weight	10 tons

3. POWER SUPPLY.

Type	Diesel/Generator
Output	20 kw.
	440 volt
	3 phase

4. PREHEAT BURNER.

Fuel	Propane
Maximum Output	4 million BTU/hr.
Consumption	40 gal./hr. (IMP.)

(Buner type oil burner also available - details upon request).

OPERATION

The R.O.T.R.I.N. Incinerator is able to process any combination of oil and sand.

If the proportion of oil in the mixture is 5% or more, the kiln can be operated with the propane burner switched off (after operating temperature has been reached).

Maximum Internal Temperature.

Kiln	1500°F.
Afterburner	2100°F.

Stack Smoke Opacity.

15-20% (Ringlemann 2)

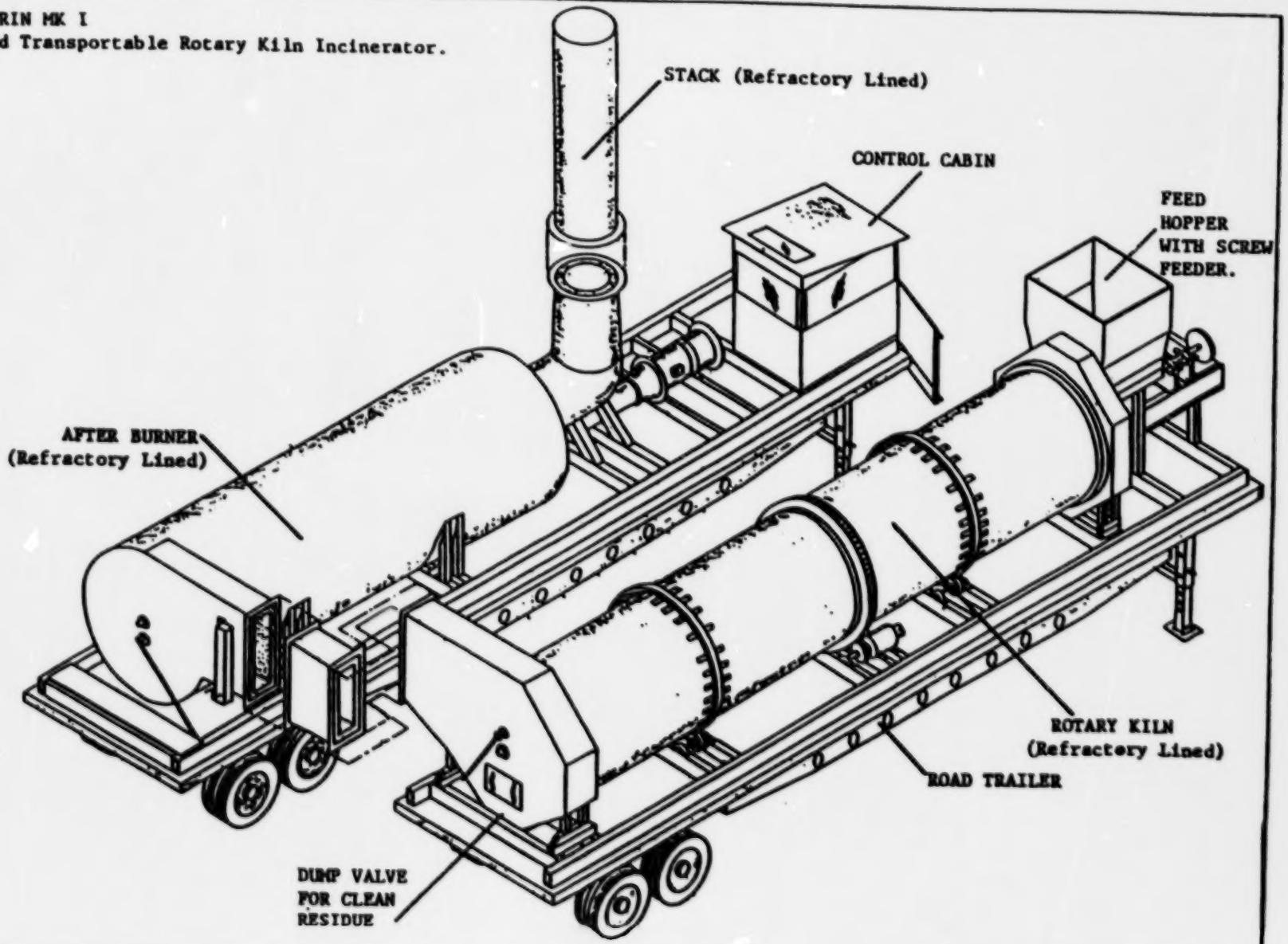
PERFORMANCE

The Mk.I R.O.T.R.I.N. kiln will process 10 tons/hr. of oil waste, with an oil content not greater than 15% by weight. This is 3000 lbs. of oil per hour.

The incineration of the oily waste is accomplished with a minimum of smoke contaminants, using a water spray scrubber system.

The oily wastes include:
- refinery sludge
- all grades of fuel oil
- oil & sand mixtures.

ROTRIN MK I
Road Transportable Rotary Kiln Incinerator.



APPENDIX D

INCINERATOR GUIDELINES
AND
EPA TOXICITY METHOD

5. INCINERATOR EMISSION GUIDELINES

5.1 General

All air contaminant emissions from incinerators should be limited so that their effect on the ambient air does not

- endanger the health, safety or welfare of any individual,
- interfere with normal enjoyment of life or property,
- endanger the health of animal life, and
- cause damage to plant life or to property.

Most incinerators with adequate flue gas treatment will meet all of the specific requirements of these guidelines, provided they are designed and operated properly.[2]

5.2 Specific Emission Limits

The specific emission limits for incinerators are as follows:

(1) Visible Emissions

(a) No person should operate an existing incinerator which produces visible emissions in excess of an opacity of 40% averaged over a period of six consecutive minutes.

(b) No person should install or operate a new incinerator which produces visible emissions in excess of an opacity of 20% averaged over a period of six consecutive minutes.

(2) Particulate Emissions
Refuse incinerators with a capacity of

(a) greater than 220 kg/h should be designed and operated in a manner which results in the concentration of particulates in the flue gas not exceeding 0.2 kilogram/1000 kilogram of flue gas.

(b) less than 220 kg/h should be designed and operated in a manner which results in the concentration of particulates in the flue gas not exceeding 0.6 kilogram/1000 kilogram of flue gas.

(3) Gaseous Emissions

(a) Hydrogen Chloride

(i) No person should operate an incinerator from which the contaminants discharged to the atmosphere contain hydrogen chloride in excess of 100 parts per million by volume (ppmv) on a dry basis and corrected to 50% excess air.[8]

(ii) Hydrogen chloride in the ambient air should not exceed 0.06 ppmv as a 1/2 hour average concentration because of the incinerator emissions.[11]

(b) Sulphur Dioxide

(i) No person should operate an incinerator from which the contaminants discharged to the atmosphere contain sulphur dioxide in excess of 250 ppmv on a dry basis and corrected to 50% excess air.[8]

(ii) Sulphur dioxide in the ambient air should not exceed 0.17 ppmv as a one hour concentration because of emissions from an incinerator.

(c) Nitrogen Dioxide

(i) Nitrogen dioxide in the ambient air should not exceed 0.21 ppmv as a one hour concentration because of emissions from an incinerator.

*NOTE: In some special cases, such as large incinerators or sensitive locations, more stringent requirements may be applied.

METHOD 1310

EXTRACTION PROCEDURE (EP) TOXICITY TEST METHOD

AND STRUCTURAL INTEGRITY TEST

1.0 Scope and Application

1.1 The extraction procedure (EP) described in this method is designed to simulate the leaching a waste will undergo if disposed of in an improperly designed sanitary landfill. Method 1310 is applicable to liquid, solid and multiphasic samples.

2.0 Summary of Method

2.1 If a representative sample of the waste contains more than 0.5% solids, the solid phase of the sample is extracted with deionized water which is maintained at a pH of 5 $\pm$ 0.2 using acetic acid. The extract is analyzed to determine if any of the threshold limits listed in Table 1 are exceeded. Table 1 also specifies the approved method of analysis. Wastes that contain less than 0.5% solids are not subjected to extraction, but are directly analyzed and evaluated in a manner identical to that of extracts.

3.0 Interferences

3.1 Potential interferences that may be encountered during analysis are discussed in the individual analytical methods referenced in Table 1.

4.0 Apparatus and Materials

4.1 Extractor: For purposes of this test, an acceptable extractor is one that will impart sufficient agitation to the mixture to (1) prevent stratification of the sample and extraction fluid and (2) ensure that all sample surfaces are continuously brought into contact with well-mixed extraction fluid. Examples of suitable extractors are shown in Figures 1-3 of this method and Section 2.2 of this manual and are available from Associated Designs & Manufacturing Co., Alexandria, Virginia; Kraft Apparatus Inc., Mineola, New York; Millipore, Bedford, Massachusetts; and Rexnard, Milwaukee, Wisconsin.

4.2 pH Meter or pH Controller (Chemtrix Inc., Hillsboro, Oregon, is a possible source of a pH controller).

4.3 Filter Holder: A filter holder capable of supporting a 0.45 Um filter membrane and able to withstand the pressure needed to accomplish separation. Suitable filter holders range from simple vacuum units to relatively complex systems that can

exert up to 5.3 kg/cm^3 (75 psi) of pressure. The type of filter holder used depends upon the properties of the mixture to be filtered. Filter holders known to EPA and deemed suitable for use are listed in Table 2.

TABLE 1 - MAXIMUM CONCENTRATION OF CONTAMINANTS FOR CHARACTERISTIC OF EP TOXICITY

Contaminant	Maximum Concentration (mg/L)	Analytical Method
Arsenic	5.0	7060, 7061
Barium	100.0	7080, 7081
Cadmium	1.0	7130, 7131
Chromium	5.0	7190, 7191
		7195*
		7196*
		7197*
Lead	5.0	7420, 7421
Mercury	0.2	7470
Selenium	1.0	7740, 7741
Silver	5.0	7760, 7761
Endrin	0.02	8080
Lindane	0.4	8080
Methoxychlor	10.0	8080
Toxaphene	0.5	8180
2,4-D	10.0	8150
2,4,5-TP (Silvex)	1.0	8150

* Methods used for determining hexavalent chromium.

4.4 Filter Membrane: Filter membrane suitable for conducting the required filtration shall be fabricated from a material which: (1) is not physically changed by the waste material to be filtered, and (2) does not absorb or leach the chemical species for which a waste's EP Extract will be analyzed. Table 3 lists filter media known to the agency and generally found to be suitable for solid waste testing.

4.4.1 In cases of doubt, contact the filter manufacturer to determine if the membrane or the prefilter are adversely affected by the particular waste. If no information is available, submerge the filter in the waste's liquid phase. After 48 hours, a filter that undergoes visible physical change (i.e. curls, dissolves, shrinks, or swells) is unsuitable for use.

TABLE 2 - EPA-APPROVED FILTER HOLDERS

Manufacturer	Size	Model No.	Comments
Vacuum Filters			
Nalgene	500 mL	44-0045	Disposable plastic unit, includes prefilter and filter pads, and reservoir; should be used when solution is to be analyzed for inorganic constituents.
Nuclepore	47 mm	410400	
Millipore	47 mm	XX10 047 00	
Pressure Filters			
Nuclepore	142 mm	425900	
Micro Filtration Systems	142 mm	302300	
Millipore	142 mm	YT30 142 HW	

TABLE 3 - EPA-APPROVED FILTRATION MEDIA

Supplier	Filter to be Used for Aqueous Systems	Filter to be Used for Organic Systems
Coarse Prefilter		
Gelman	61631, 61635	61631, 61635
Nuclepore	210907, 211707	210907, 211707
Millipore	AP25 035 00, AP25 127 50	AP25 035 00, AP25 127 50
Medium Prefilters		
Nuclepore	210905, 211705	210905, 211705
Millipore	AP20 035 00, AP20 124 50	AP20 035 00, AP20 124 50
Fine Prefilters		
Gelman	64798, 64803	64798, 64803
Nuclepore	210903, 211703	210903, 211703
Millipore	AP15 035 00, AP15 124 50	AP15 035 00, AP15 124 50
Fine filters (0.45 Um)		
Gelman	60173, 60177	60540 or 66149, 60544 or 66151
Pall	NX04750, NX14225	
Nuclepore	142218	142218[a]
Millipore	HAWP 047 00, HAWP 142 50	FHUP 047 00, FHLP 142 50
Selas	83485-02, 83486-02	83485-02, 83486-02

[a]Susceptible to decomposition by certain polar organic solvents.

4.4.2.1 Prepare a standard solution of the chemical species of interest.

4.4.2.2 Analyze the standard for its concentration of the chemical species.

4.4.2.3 Filter the standard and re-analyze. If the concentration of the filtrate differs from the original standard, the filter membrane leaches or absorbs one or more of the chemical species.

4.5 Structural integrity tester: Having a 3.18 cm (1.25 in) diameter hammer weighing 0.33 kg (0.73 lb) and having a free fall of 15.24 cm (6 in.) shall be used. This device is available from Associated Design and Manufacturing Company, Alexandria, VA 22314, as Part No. 125, or it may be fabricated to meet the specifications shown in Figure 4.

5.0 Reagents

5.1 Deionized Water: Water should be monitored for impurities.

5.2 0.5 N Acetic Acid: This can be made by diluting concentrated glacial acetic acid (17.5 N). The glacial acetic acid should be of high purity and monitored for impurities.

5.3 Analytical standards should be prepared according to the analytical methods referenced in Table 1.

6.0 Sample Collection, Preservation and Handling

6.1 All samples must be collected using a sampling plan that addresses the considerations discussed in Section One of this manual.

6.2 Preservatives must not be added to samples.

6.3 Samples can be refrigerated if it is determined that refrigeration will not affect the integrity of the sample.

7.0 Procedure

7.1 If the waste does not contain any free liquid, go to Section 7.9. If the sample is liquid or multiphase, continue as follows. Weigh filter membrane and prefilter to $\pm$ 0.01 g. Handle membrane and prefilters with blunt curved-tip forceps or vacuum tweezers, or by applying suction with a pipette.

7.2 Assemble filter holder, membranes and prefilters following the manufacturer's instructions. Place the 0.45 Um membrane on the support screen and add prefilters in ascending order of pore size. Do not prewet filter membrane.

7.3 Weigh out a representative subsample of the waste (100 g minimum).

7.4 Allow slurries to stand to permit the solid phase to settle. Wastes that settle slowly may be centrifuged prior to filtration.

7.5 Wet the filter with a small portion of the waste's or extraction mixture's liquid phase. Transfer the remaining material to the filter holder and apply vacuum or gentle pressure (10 - 15 psi) until all liquid passes through the filter. Stop filtration when air or pressurizing gas moves through the membrane. If this point is not reached under vacuum or gentle pressure, slowly increase the pressure in 10 psi increments to 75 psi. Halt filteration when liquid flow stops. This liquid will constitute part or all of the extract (refer to Section 7.16). The liquid should be refrigerated until time of analysis.

NOTE: Oil samples or samples which contain oil are treated in exactly the same way as any other sample. The liquid portion of the sample is filtered and treated as part of the EP extract. If the liquid portion of the sample will not filter (this is usually the case with heavy oils or greases) it is carried through the EP extraction as a solid.

7.6 Remove the solid phase and filter media and, while not allowing it to dry, weigh to $\pm$ 0.01 g. The wet weight of the residue is determined by calculating the weight difference between the weight of the filters (Section 7.1) and the weight of the solid phase and the filter media.

7.7 The waste will be handled differently from this point on depending on whether it contains more or less than 0.5% solids. If the sample appears to have less than 0.5% solids, the percent solids will be determined by the following procedure.

7.7.1 Dry the filter and residue at 80°C until two successive weighings yield the same value.

7.7.2 Calculate the percent solids using the following equation:

$$\frac{\text{weight of filtered solid and filters} - \text{tared weight of filters}}{\text{initial weight of waste material}} \times 100 = \% \text{ Solids}$$

NOTE: This procedure is only used to determine whether the solid must be extracted or whether it can be discarded unextracted. It is not used in calculating the amount of water or acid to use in the extraction step. Do not extract solid material that has been dried at 80°C. A new sample will have to be used for extraction if a percent solids determination is performed.

7.8 If the solid comprises less than 0.5% of the waste, discard the solid and proceed immediately to Section 7.17, treating the liquid phase as the extract.

7.9 The solid materials obtained from Section 7.5 and all materials that do not contain free liquids should be evaluated for particle size. If the solid material has a surface area per gram of material equal to or greater than 3.1 cm^2 or passes through a 9.5 mm (0.375 in.) standard sieve, the operator should proceed to Section 7.11. If the surface area is smaller or the particle size larger than specified above, the solid material would be prepared for extraction by crushing, cutting or grinding the material so that it passes through a 9.5 mm (0.375 in.) sieve or, if the material is in a single piece, by subjecting the material to the "Structural Integrity Procedure" described in Section 7.10.

7.10 Structural Integrity Procedure (SIP):

7.10.1 Cut a 3.3 cm diameter by 7.1 cm long cylinder from the waste material. For wastes that have been treated using a fixation process, the waste may be cast in the form of a cylinder and allowed to cure for 30 days prior to testing.

7.10.2 Place waste into sample holder and assemble the tester. Raise the hammer to its maximum height and drop. Repeat 14 additional times.

7.10.3 Remove solid material from tester and scrape off any particles adhering to sample holder. Weigh the waste to the nearest 0.01 gram and transfer it to the Extractor.

7.11 If the sample contains more than 0.5% solids, use the wet weight of the solid phase obtained in Section 7.6 for purposes of calculating the amount of liquid and acid to employ for extraction by using the following equation:

$$W = W_f - W_t$$

where:

W = wet weight in grams of solid to be charged to extractor

W_f = wet weight in grams of filtered solids and filter media

W_t = weight in grams of tared filters

If the waste does not contain any free liquids, 100 grams of the material will be subjected to the extraction procedure.

7.12 Place the appropriate amount of material (refer to Section 7.11) into the extractor and add 16 times its weight of deionized water.

7.13 After the solid material and deionized water are placed in the extractor, the operator should begin agitation and measure the pH of the solution in the extractor. If the pH is greater than 5.0, the pH of the solution should be decreased to 5.0 $\pm$ 0.2 by adding 0.5 N acetic acid. If the pH is equal to or less than 5.0, no acetic acid should be added. The pH of the

solution should be monitored, as described below, during the course of the extraction and, if the pH rises above 5.2, 0.5 N acetic acid should be added to bring the pH down to 5.0 ± 0.2. However, in no event shall the aggregate amount of acid added to the solution exceed 4 mL of acid per gram of solid. The mixture should be agitated for 24 hours and maintained at 20 to 40°C (68 to 104°F) during this time. It is recommended that the operator monitor and adjust the pH during the course of the extraction with a device such as the Type 45-A pH Controller manufactured by Chemtrix, Inc., Hillsboro, Oregon 97123 or its equivalent, in conjunction with a metering pump and reservoir of 0.5 N acetic acid. If such a system is not available, the following manual procedure shall be employed.

7.13.1 A pH meter should be calibrated in accordance with the manufacturer's specifications.

7.13.2 The pH of the solution should be checked and, if necessary, 0.5 N acetic acid should be manually added to the extractor until the pH reaches 5.0 ± 0.2. The pH of the solution should be adjusted at 15-, 30-, and 60-minute intervals, moving to the next longer interval if the pH does not have to be adjusted more than 0.5 pH units.

7.13.3 The adjustment procedure should be continued for at least 6 hours.

7.13.4 If, at the end of the 24 hour extraction period, the pH of the solution is not below 5.2 and the maximum amount of acid (4 mL per gram of solid) has not been added, the pH should be adjusted to 5.0 ± 0.2 and the extraction continued for an additional 4 hours, during which the pH should be adjusted at 1 hour intervals.

7.14 At the end of the extraction period, deionized water should be added to the extractor in an amount determined by the following equation:

$$V = (20)\,W - 16\,(W) - A$$

where:

V = mL deionized water to be added.
W = weight in grams of solid charged to extractor
A = mL of 0.5 N acetic acid

7.15 The material in the extractor should be separated into its component liquid and solid phases in the following manner.

7.15.1 Allow slurries to stand to permit the solid phase to settle (wastes that are slow to settle may be centrifuged prior to filtration) and set up the filter apparatus (refer to Section 4.3 and 4.4).

7.15.2 Wet the filter with a small amount of the waste's or extraction mixture's liquid phase. Transfer the remaining material to the filter holder and apply pressure until all liquid

passes through the filter. Stop filtration when air or pressurizing gas moves through the membrane. If this point is not reached under vacuum or gentle pressure, slowly increase the pressure in 10 psi increments to 75 psi. Halt filtration when liquid flow stops.

7.16 The liquids resulting from Sections 7.5 and 7.15 should be combined. This combined liquid (or the waste itself if it has less than 0.5% solids, as noted in Section 7.8) is the extract and should be analyzed for the presence of any of the contaminants specified in Table 1 using the Analytical Procedures designated in Section 7.17.

7.17 The extract will be prepared and analyzed according to the analytical methods specified in Table 1. All of these analytical methods are included in this manual. The method of standard addition will be employed for all metal analyses.

NOTE: If the EP extract includes two phases, concentration of contaminants is determined by using a simple weighted average. For example: An EP extract contains 50 mL of oil and 1,000 mL of an aqueous phase. Contaminant concentrations are determined for each phase. The final contamination concentration is taken to be:

$$\frac{(50)\ (\text{conc. in oil})}{1{,}050} + \frac{(1000)\ (\text{conc. of aqueous phase})}{1{,}050}$$

7.18 The extract concentrations are compared to the maximum contamination limits listed in Table 1. If the extract concentrations are equal to or greater than the respective values, then the waste is considered to be EP Toxic.[1]

[1] Chromium concentrations have to be interpreted differently. A waste containing chromium will be determined to be EP toxic if (1) the waste extract has an initial pH of less than 7 and contains more than 5 mg/L of hexavalent chromium in the resulting extract, or (2) the waste extract has an initial pH greater than 7 and final pH greater than 7 and contains more than 5 mg/L of hexavalent chromium in the extract, or (3) the waste extract has an initial pH greater than 7 and final pH less than 7 and contains more than 5 mg/L of total chromium, unless the chromium is trivalent. To determine whether the chromium is trivalent, the sample must be processed according to an alkaline digestion method (Method 3060) and analyzed for hexavalent chromium (Methods 7195, 7196, or 7197).

8.0 Quality Control

8.1 All quality control data should be maintained and available for easy reference or inspection.

8.2 Employ a minimum of one blank per sample batch to determine if contamination or any memory effects are occurring.

8.3 All quality control measures suggested in the referenced analytical methods should be followed.

2.1.4 Extraction Procedure Toxicity

Introduction

The Extraction Procedure (EP) is designed to simulate the leaching a waste will undergo if disposed of in a sanitary landfill. This test is designed to simulate leaching that takes place in a sanitary landfill only. It is a laboratory test in which a representative sample of a waste is extracted with distilled water maintained at a pH of 5 using acetic acid. The extract obtained from the EP (the "EP Extract") is then analyzed to determine if any of the thresholds established for the eight elements (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), four pesticides (Endrin, Lindane, Methoxychlor, Toxaphene), and two herbicides (2,4,5-trichlorophenoxypropionic acid, 2,4-dichlorophenoxyacetic acid) have been exceeded. If the EP Extract contains any one of the above substances in an amount equal to or exceeding the levels specified in 40 CFR 261.24, the waste possesses the characteristic of Extraction Procedure Toxicity and is a hazardous waste.

Summary of Procedure

The Extraction Procedure consists of five steps (refer to Figure 5):

1. Separation Procedure

A waste containing unbound liquid is filtered and if the solid phase is less than 0.5% of the waste, the solid phase is discarded and the filtrate analyzed for trace elements, pesticides, and herbicides (step 5). If the waste contains more than 0.5% solids, the solid phase is extracted and the liquid phase stored for later use.

2. Structural Integrity Procedure / Particle Size Reduction

Prior to extraction, the solid material must pass through a 9.5 mm (0.375 in) standard sieve, have a surface area per gram of waste of 3.1 cm^2, or, if it consists of a single piece, be subjected to the Structural Integrity Procedure. The Structural Integrity Procedure is used to demonstrate the ability of the waste to remain intact after disposal. If the waste does not meet one of these conditions it must be ground to pass the 9.5 mm sieve.

3. Extraction of Solid Material

The solid material from step 2 is extracted for 24 hours in an aqueous medium whose pH is maintained at or below 5 using 0.5 N acetic acid. The pH is maintained either automatically or manually. (In acidifying to pH 5, no more than 4.0 g of acid solution per g of material being extracted may be used.)

4. Final Separation of the Extraction from the Remaining Solid

After extraction, the liquid:solid ratio is adjusted to 20:1 and the mixed solid and extraction liquid are separated by filtration. The solid is discarded and the liquid combined with any filtrate obtained in step 1. This is the EP Extract that is analyzed and compared to the threshold listed in Table 1 of 40 CFR 261.24.

5. Testing (Analysis) of EP Extract

Inorganic and organic species are identified and quantified using the appropriate methods in the 7000 and 8000 series of methods in this manual.

Regulatory Definition

A solid waste exhibits the characteristic of EP toxicity if, using the appropriate test methods described in this manual or equivalent methods approved by the Administrator under the procedures set forth in 40 CFR 260.20 and 260.21, the extract from a representative sample of the waste contains any of the contaminants listed in Table 1 at a concentration equal to or greater than the respective value given in that Table. If a waste contains less than 0.5% filterable solids, the waste itself, after filtering, is considered to be the extract for the purposes of analysis.

A solid waste that exhibits the characteristic of EP toxicity, but is not listed as a hazardous waste in Subpart D, is assigned EPA Hazardous Waste Numbers that correspond to the toxic contaminants causing it to be hazardous. These numbers are specified in Table 1.

TABLE 1 - MAXIMUM CONCENTRATION OF CONTAMINANTS
FOR CHARACTERISTIC OF EP TOXICITY

EPA Hazardous Waste Number	Contaminant	Maximum Concentration (mg/L)
D004	Arsenic	5.0
D005	Barium	100.0
D006	Cadmium	1.0
D007	Chromium (6)	5.0
D008	Lead	5.0
D009	Mercury	0.2
D010	Selenium	1.0
D011	Silver	5.0
D012	Endrin	0.02
D013	Lindane	0.4
D014	Methoxychlor	10.0
D015	Toxaphene	0.5
D016	2,4-D	10.0
D017	2,4,5-TP (Silvex)	1.0

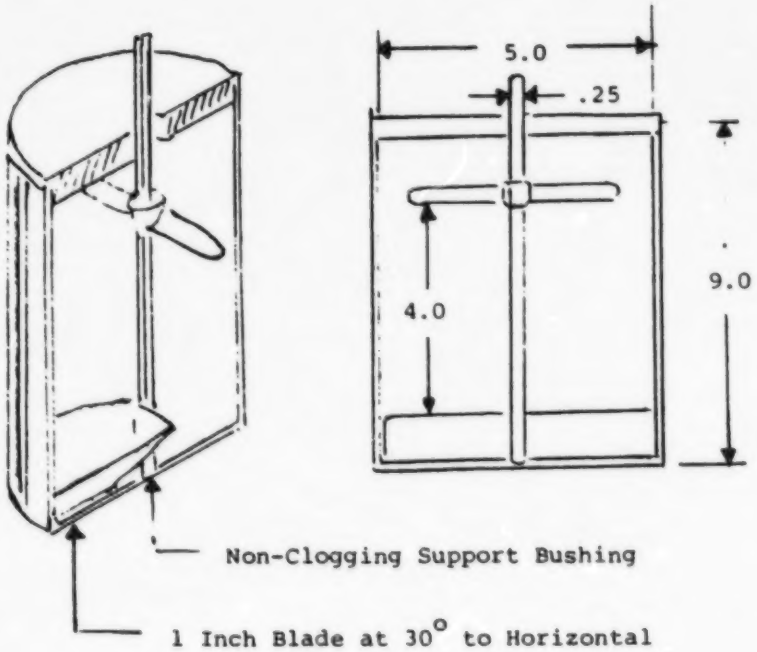


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Figure 1 - Extractor

SCALE	DATE	MADE	CHKD.	JOB:	PLATE

HT12 - 79/08

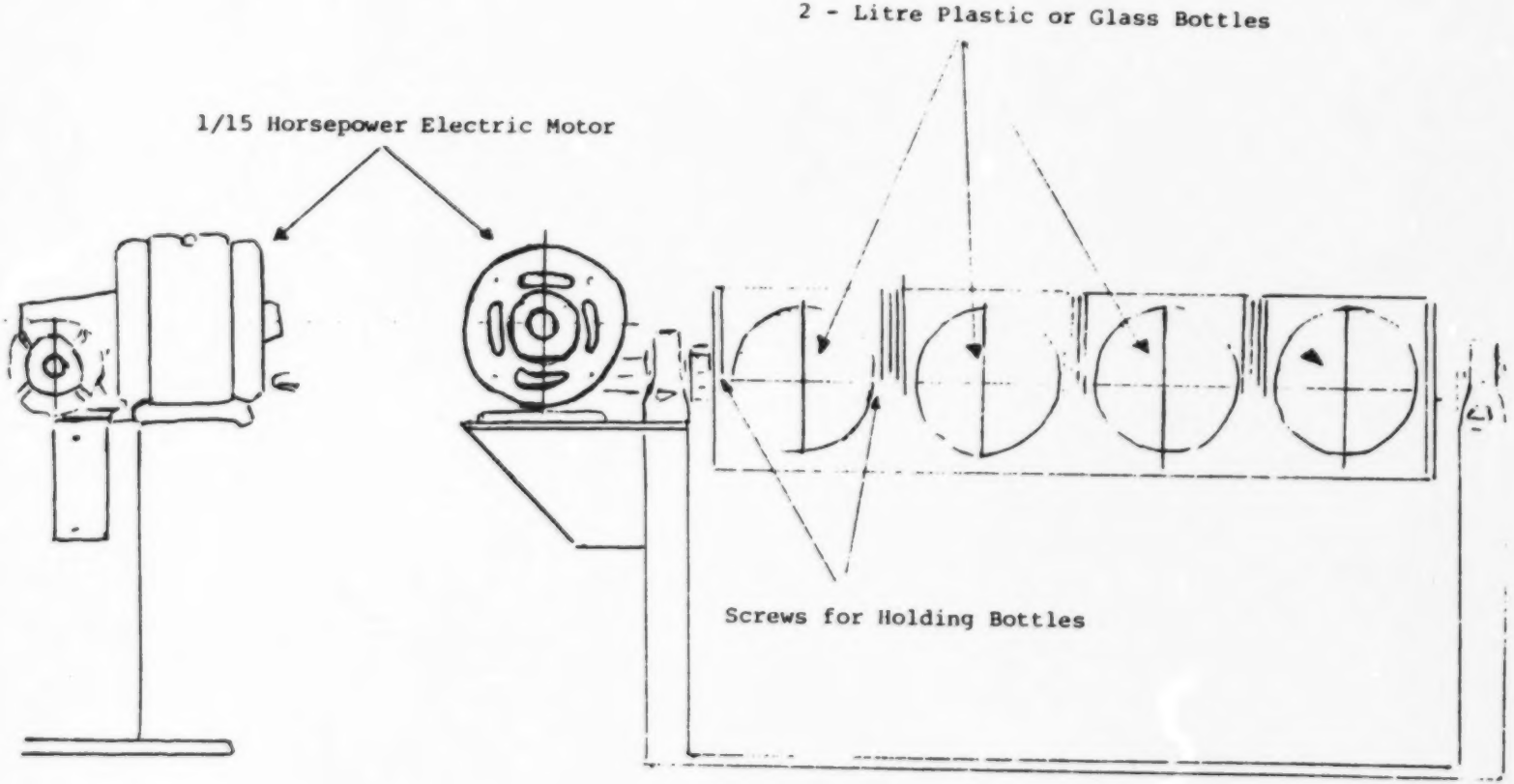

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Figure 2 - Rotary Extractor

SCALE	DATE	MADE	CHKD.	JOB:	PLATE

HT13 79/06

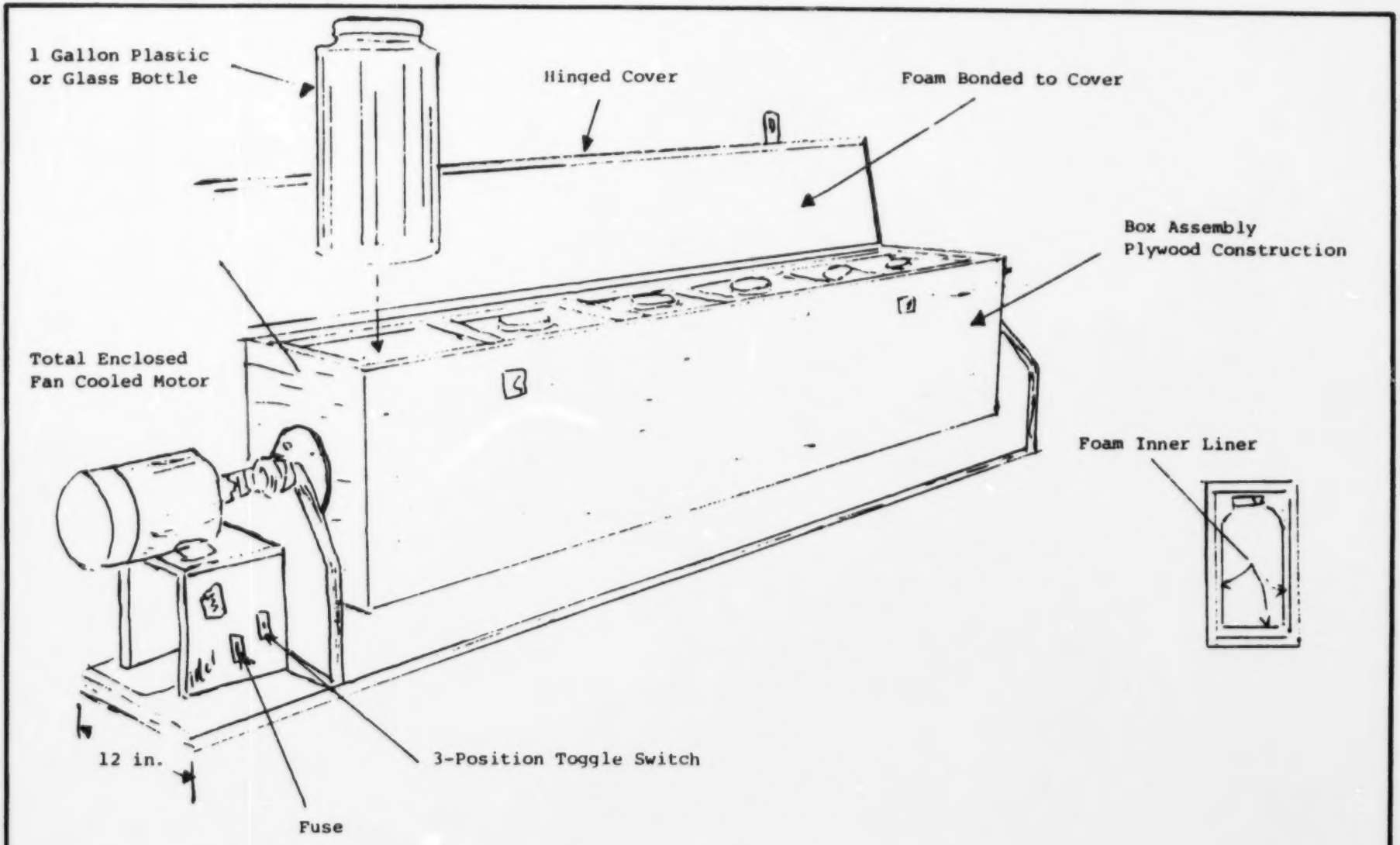

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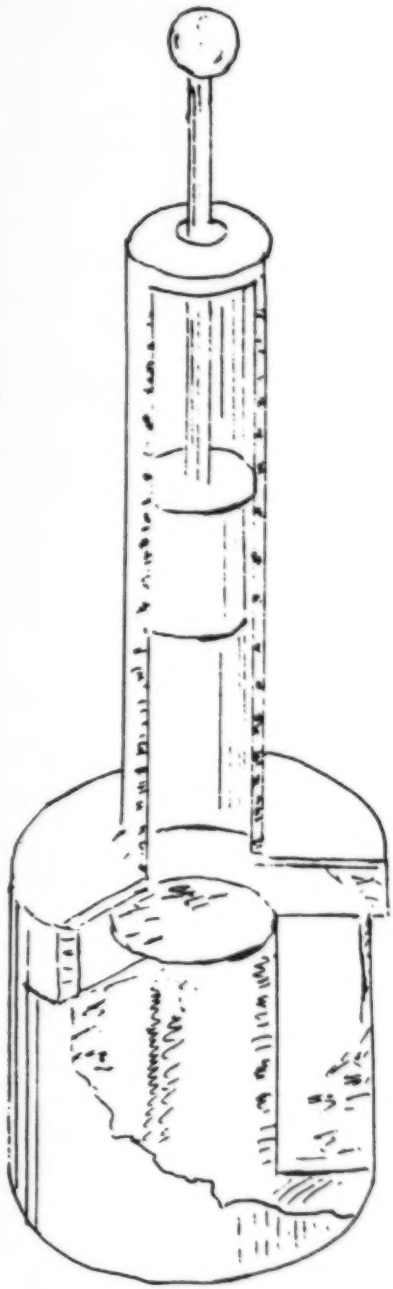
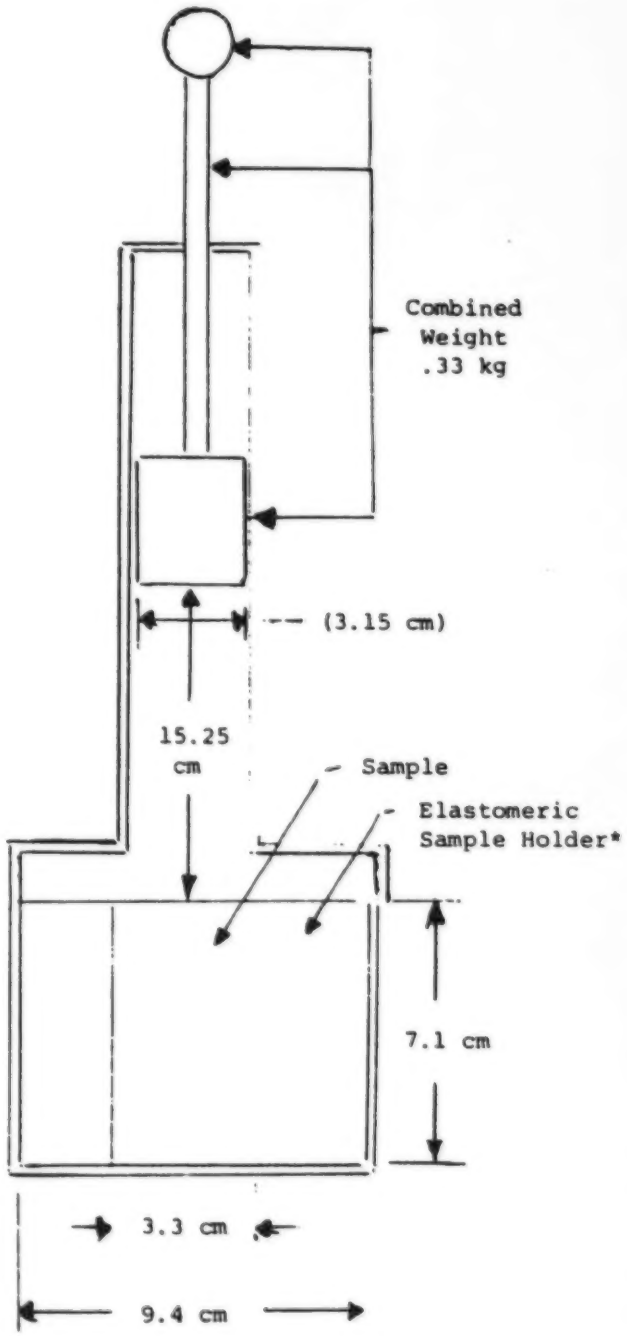
Figure 3 - EPRI Extractor

SCALE	DATE	MADE	CHKD.	JOB:	PLATE





*Elastomeric sample holder fabricated of material firm enough to support the sample.

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Figure 4 - Structural Integrity Tester

SCALE	DATE	MADE	CHKD.	JOB:	PLATE

HT12 - 79/05

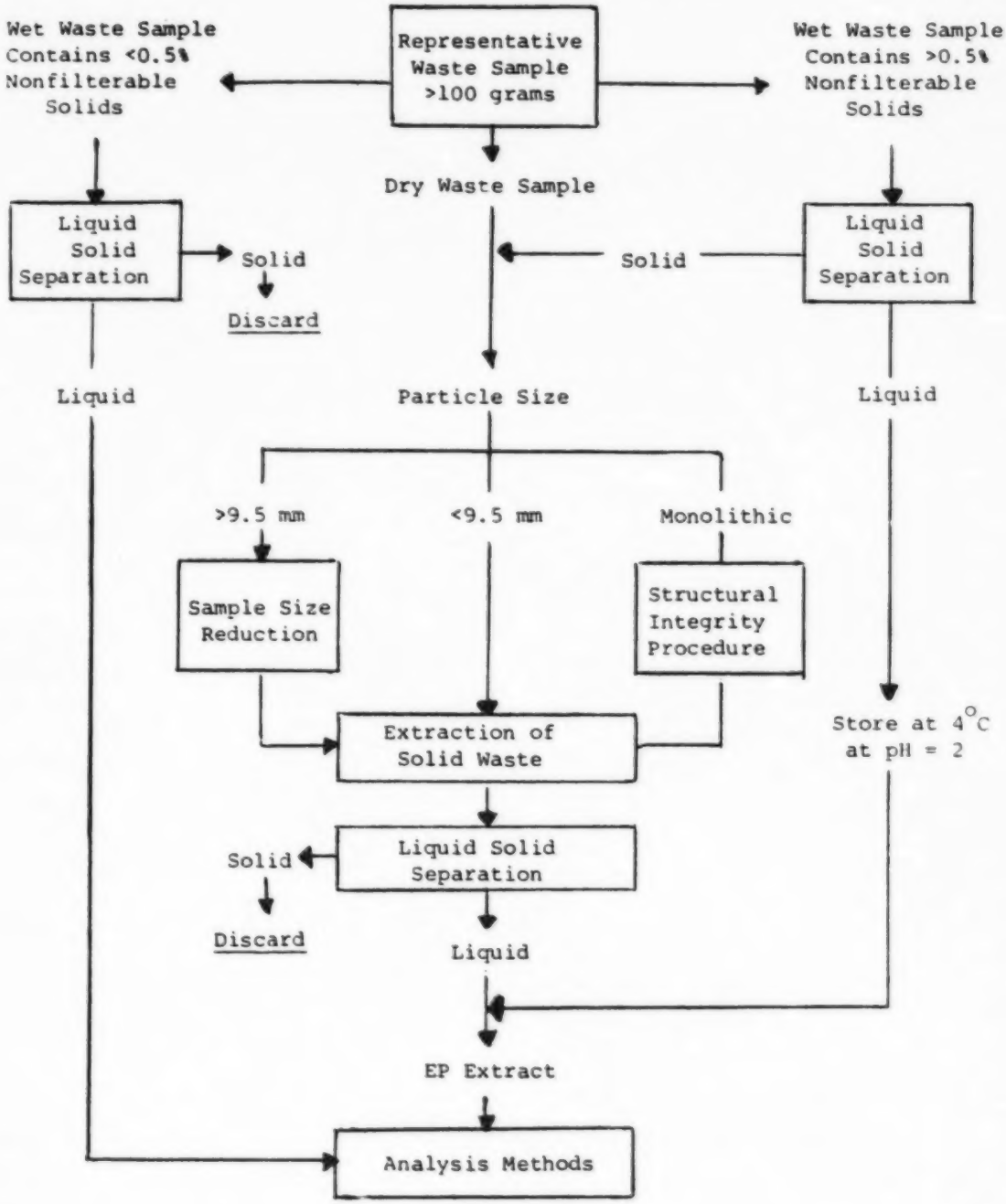

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Figure 5 - Extraction Procedure Flowchart

SCALE	DATE	MADE	CHKD.	JOB:	PLATE

HY12 - 79 05

APPENDIX E

PHOTOGRAPHS

PHOTO 1. *INCINERATOR BEFORE TESTING*

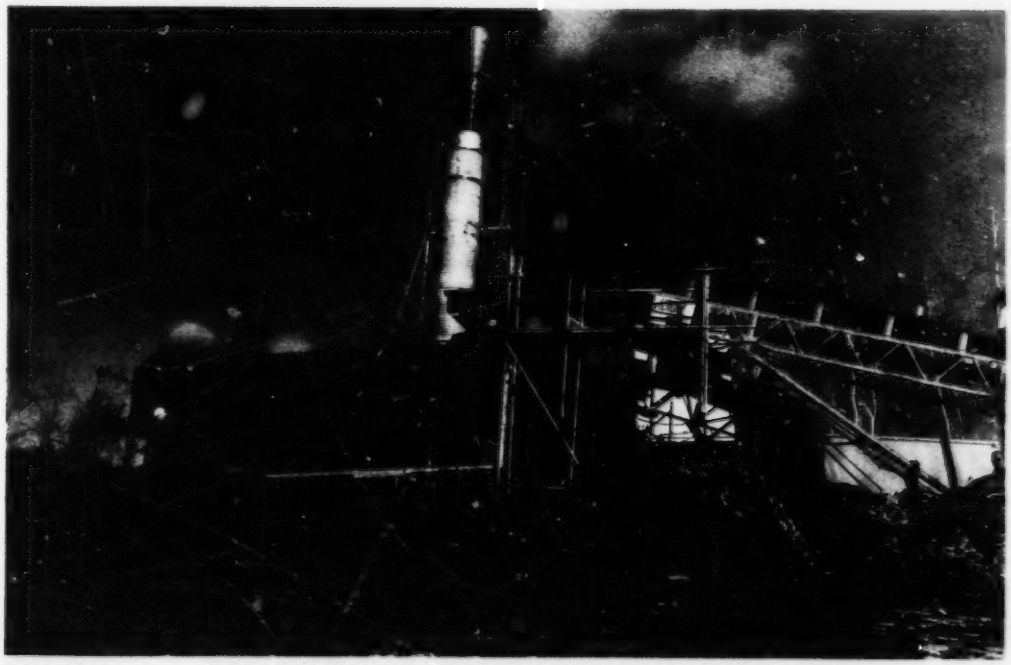

PHOTO 2. *ROTARY KILN INCINERATOR DURING EMISSION SURVEY. NOTE THAT THERE IS VERY LITTLE PLUME.*

PHOTO 3.

PHOTO 4.

OTHER PHOTOGRAPHS DURING THE EMISSION SURVEY. AGAIN THERE IS VERY LITTLE PLUME.

PHOTO 5.

PHOTO 6. *GENERAL SITE PLAN. COVERED AREA IS THE ECOLOGY PIT WHERE THE WASTES ARE STORED.*

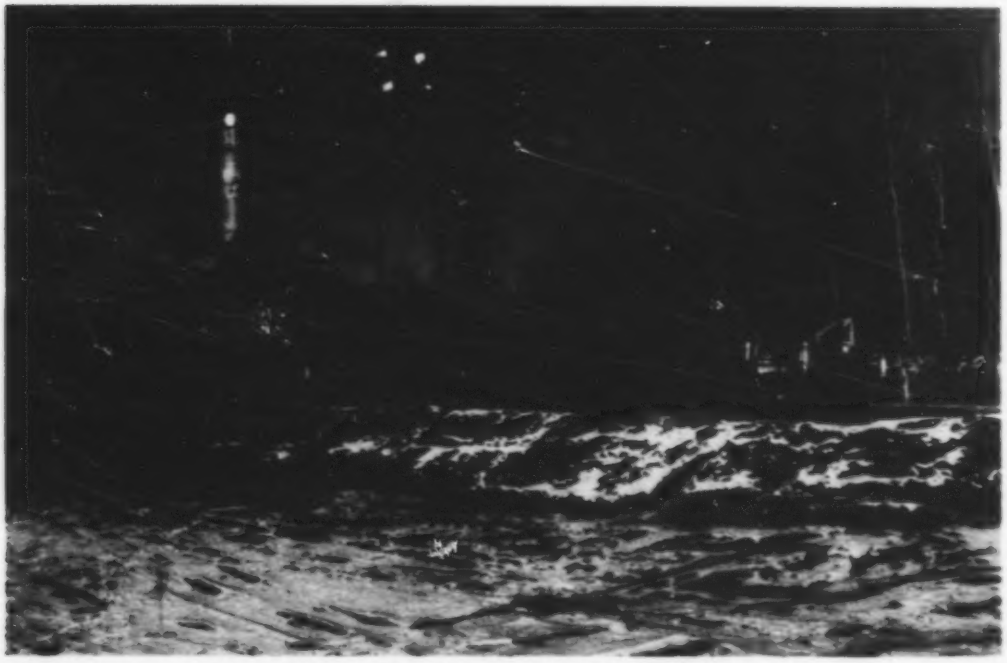

PHOTO 7. *LOADING OF OILY WASTE IS ABOUT TO BEGIN. THE MIXED WASTE IS IN THE BOBCAT BUCKET.*

PHOTO 8. WASTE LOADING

PHOTO 9. MATERIAL DUMPED ON TO CONVEYOR BELT.

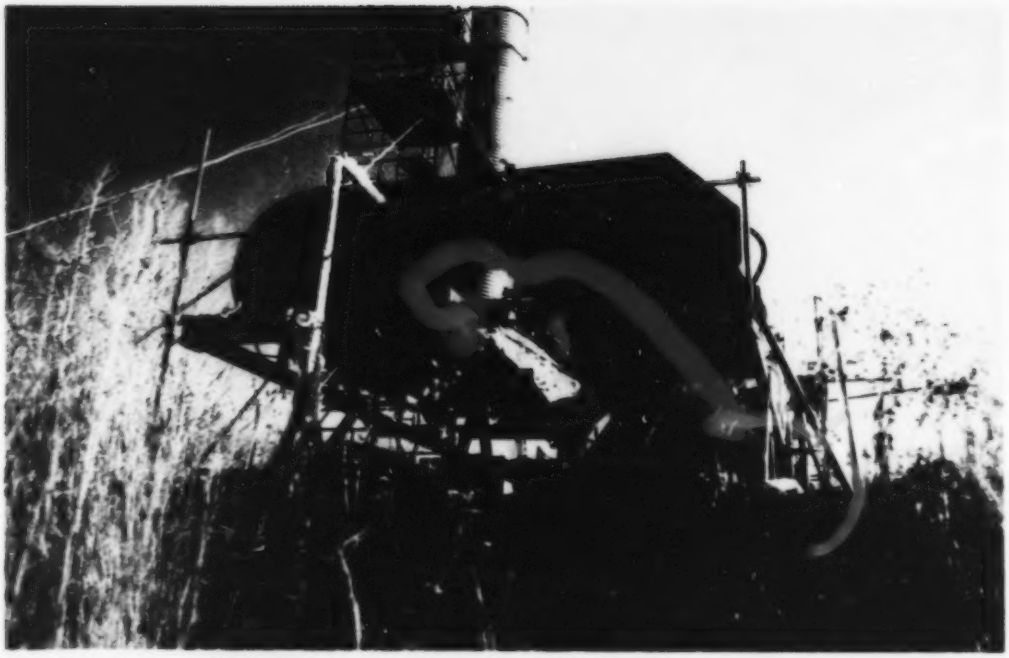

PHOTO 10. *ASH REMOVAL UTILISES THE CHANNEL AT THE RIGHT.*

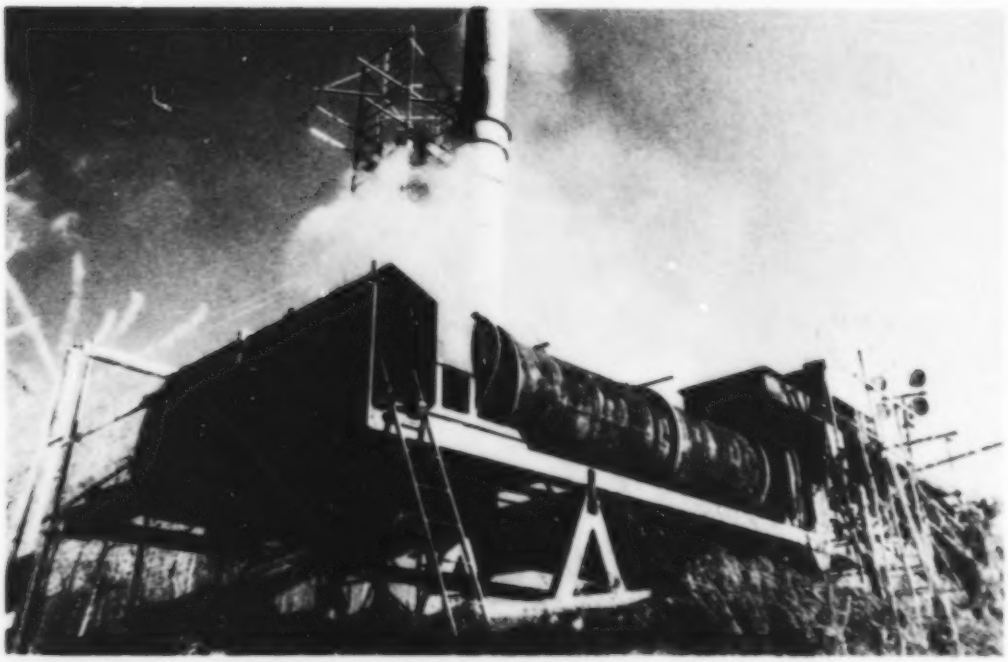

PHOTO 11. *ASH IS REMOVED FROM THE KILN DOWN THE METAL CHANNEL. NOTE THE FUGITIVE EMISSIONS FROM THE ROTARY KILN.*

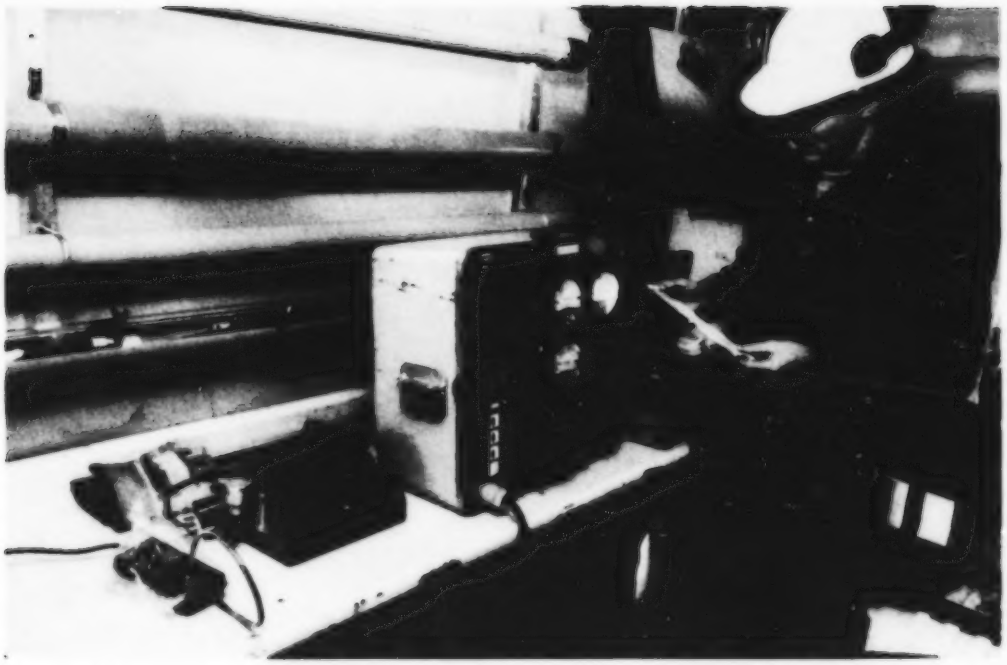

PHOTO 12. THE SAMPLING EQUIPMENT CONTROL CONSOLE. THE SMALL NOVA MACHINE MONITORS CO, CO_2, O_2 CONTINUOUSLY.

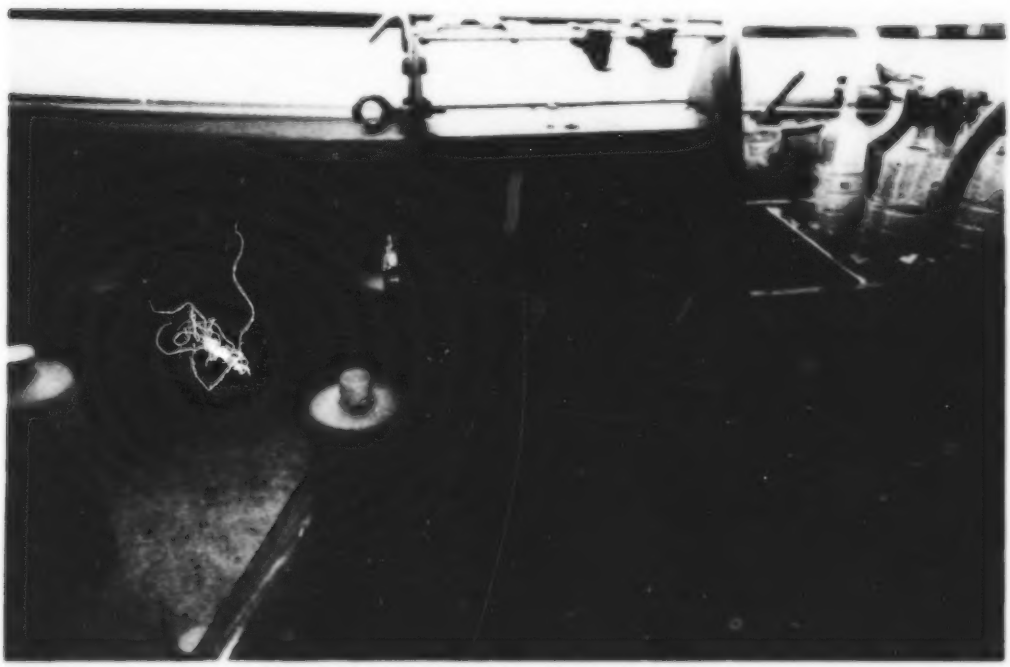

PHOTO 13. SAMPLE RECOVERY. THE GLASS IMPINGER SOLUTIONS ARE COLLECTED FOR ANALYSIS. THE PARTICULAR FILTER IS LOADED. THE DEPTH OF COLLECTED PARTICULATE WAS ABOUT 5 mm.